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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/627,418	07/27/2000	Tatsuya Usami	00N010-US	1182

7590 11/20/2002

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EXAMINER

QUACH, TUAN N

ART UNIT PAPER NUMBER

2814

DATE MAILED: 11/20/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/627,418

Applicant(s)

USAMI, TATSUYA

Examiner

Tuan Quach

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 01 November 2002.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-5 and 14 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 14 is/are allowed.
- 6) ☒ Claim(s) 1-5 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 27 July 2000 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other: _____

DETAILED ACTION

The amendment after final filed August 29, 2002 has been permitted entry; the Finality of the Office action mailed June 3, 2002 (Paper No. 9) remains and is repeated below, including any further discussions regarding the newly amended features.

The requirement for a supplemental oath or declaration in Paper No. 9 page 2, first full paragraph, is maintained and repeated as delineated therein. Contrary to applicant's argument, the original claim 1 only recites an insulating layer " and is silent regarding any multi-layer insulating layer and further does not recite the particular structure combination claimed in claim 14, namely a middle layer of PAE, an upper layer and a lower insulating layer of HSQ. As allowable subject matter has been indicated, applicant's reply must either comply with all formal requirements or specifically traverse each requirement not complied with. See 37 CFR 1.111(b) and MPEP § 707.07(a).

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 1-5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lopatin et al. (Lopatin) and Zhao et al. (Zhao), taken together.

Lopatin teaches copper 24 and low dielectric constant layer, e.g., layer 30 including HSQ material thus possessing the property that Cu is unlikely to entire it since the same material is employed consistent with applicant's acknowledgement on page 12 lines 1-2 that "it is obvious that HSQ has properties of preventing the diffusion of Cu." The provision of via in low dielectric constant 50 followed by barrier layer 54 and copper 58 is also taught. See column 6 line 4 to column 7 line 21. Although Lopatin does not

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explicitly recite the Cu concentration to be equal or higher than 10^{19} atoms/cm³, such would have been encompassed in Lopatin since the concentration therein is neither required nor limited to be below the said value, and since the optimization of such concentration to obtain a desired conductivity would have been obvious to one skilled in the art. Lopatin also shows the barrier which would act as the adhesion layer since it is located between the wiring lines and the insulating layer and not forbidding the adhesion therebetween. Lopatin does not recite the adhesion language, the use of tungsten and the etching rate and the polishing rate of the adhesion layer to be essentially equivalent to those of the wiring lines.

Zhao teaches the conventional use of liner in conjunction with copper wherein the barrier also provides adhesion, including the use of tungsten for such material. See column 4 line 52 to column 5 lines 25-63. The provision of openings 24 and 25 in various low dielectric constant material, e.g., layer 14, followed by copper conductor, e.g., 29, including barrier/adhesion is also shown. See column 6 line 10 to column 8 line 45.

It would have been obvious to one skilled in the art at the time the invention was made in practicing the above invention to have included barrier/adhesion layer in question to improve adhesion/barrier characteristics in the copper interconnect including the use of tungsten for such material. The selection of the same etching rate would have been obvious and would have been within the purview of one skilled in the art to facilitate the removal of the wiring line and the adhesion/barrier layer. Regarding the recitation concerning the polishing rate which is essentially equivalent to the polishing

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rate of the wiring lines, this corresponds to a notoriously conventional method for forming plugs by polishing the barrier/adhesion and the interconnect/wiring wherein such selection of essentially equivalent rate would facilitate the polishing and correspond to a conventional process as the polishing of excess barrier/adhesion and wiring material outside the via/trench to result in the plugs is well known, e.g., Zhao, column 8 lines 50-57, and further results in similar structures to that of the prior art, namely, plugs which are planarized with the adjacent insulating layer.

Applicant's arguments filed November 1, 2002 and August 29, 2002 have been fully considered but they are not persuasive.

Regarding the invention in claim 14, applicant points out to the disclosure at page 7 line 15 et seq. This appears to belong to a different embodiment and not the statement of the invention. The language of original claim 1 pointed out by applicant merely refers to an insulating layer which has a property that Cu is unlikely to enter and does not appear to refer to the structure of claim 14 which requires in part a multi-layer insulating structure including a middle layer of PAE and an upper insulating layer and a lower insulating between which the middle layer is sandwiched, said upper and lower layers each comprised of HSQ.

Applicant argues that Lopatin does not teach or suggest that HSQ provides protection against the diffusion of copper and that the instant specification shows in Figs 2A-4 and 5. This fails to take into consideration the evidence of record that Lopatin clearly teaches the same insulating material said in the original disclosure as possessing the property that Cu is unlikely to enter the material, e.g., HSQ, and that

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Lopatin clearly teaches the use of the HSQ insulating material when Cu wiring is employed. It remains that the use of HSQ in Cu wirings is clearly realized by Lopatin. Furthermore, the advantage alleged by applicant in Figs. 4 and 5 thus would be realized by Lopatin. The information provided and the allegation regarding the organic polymer or inorganic polymer delineated in Figs. 2A-4 further fail to characterize the particular materials, namely what the particular materials are being employed in these figures. The evidence of record however clearly supports that the use of HSQ as insulating material in conjunction with copper as wiring/interconnect is clearly taught by Lopatin. Applicant has failed to show that the copper is not unlikely to enter the insulating materials employed in Lopatin, including the same HSQ material delineated, consistent with the admission by applicant in the original disclosure. Applicant further argues that there is no recognition of the problem and of the solution of employing an insulating layer. The recognition of the problem and the solution employed by applicant has been considered together with remaining evidence and it remains the evidence of obviousness would outweigh the evidence of non-obviousness and clearly evidence the use of copper plug without any restricted concentration within the via or trench of insulating layer such as HSQ to result in a well known plug, including the inclusion of conventional barrier/adhesion frequently employed in copper plugs as evidenced by Zhao. Applicant further argues that HSQ is not singled out as a preferred low dielectric constant material in Lopatin. This has been considered but does not appear to be necessary since this cannot refute the contribution taught by Lopatin regarding the use of HSQ in Cu wiring lines, consistent with the admission by applicant. Applicant further

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fails to provide any evidence that the HSQ employed in Lopatin does not possess the characteristics that Cu unlikely to enter the insulating layer. Applicant further repeated the argument that Zhao teaches away at column 5 lines 24-26. This is nonetheless baseless as applicant fails to substantiate its argument and appears to misinterpret or ignore the explicit teachings of Zhao at column 5 lines 24-26 which recites that the liner 12 under copper 10 includes barrier materials such as TiN, TaN, W, etc., and that these materials also operate to promote adhesion.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Quach whose telephone number is 703-308-1096. The examiner can normally be reached on M - F from 9 to 5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor Wael Fahmy can be reached on (703) 308-4918. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9318 (Before Final) and (703) 872-9319 (After Final).

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Tuan Quach
Primary Examiner